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U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Attention: Document Control Desk

Subject: RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION REGARDING RESPONSE TO BULLETIN 2003-01
Oconee Nuclear Station Units 1, 2, & 3
TAC Nos. MC6288, MC6289, and MC6290

By letter dated August 7, 2003, Duke Energy Corporation submitted the 60-day response to Nuclear Regulatory Commission (NRC) Bulletin 2003-01, "Potential Impact of Debris Blockage on Emergency Sump Recirculation at Pressurized Water Reactors", dated June 9, 2003, for Oconee Nuclear Station, Units 1, 2, and 3 (ONS). The NRC staff reviewed and closed the response in a closure letter dated March 30, 2004 (ADAMS ML040830077). The review concluded that Duke's response to the bulletin adequately addressed each of the compensatory measures recommended in the bulletin.

Since that time, concerns regarding degraded containment coatings, remediation efforts and adequacy of Bulletin 2003-01 interim compensatory measures were raised by NRC staff. Based on this information, the NRC staff re-opened its review of ONS Bulletin 2003-01 response and requested additional information on March 30, 2005. ONS submitted the 30-day response to this request for additional information (RAI) on April 29, 2005.

On August 15, 2005, ONS received a second Request for Additional Information by electronic mail. The RAI consists of four questions seeking supplemental information with regard to containment coatings. The response to those questions is included as Attachment 1 to this letter.

If you have further questions or need additional information, please contact Russ Oakley at (864) 885-3829.

Very truly yours,

Bruce Hamilton /for

R. A. Jones, Vice President
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NRIA File/ELL EC05O
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ATTACHMENT 1

RESPONSE TO (ELECTRONIC) REQUEST FOR ADDITIONAL INFORMATION DATED 8/15/05 REGARDING CONTAINMENT COATINGS

OCONEE NUCLEAR STATION UNITS 1, 2, & 3

Response to NRR Questions of 8/15/05:

1.) Provide the results of the recent Unit 1 coating inspection. Also provide the complete failure analysis performed by the manufacturer (Carboline) and by the independent consultant (Jon Cavallo). When the final root cause evaluation is complete provide the root cause evaluation.

The reactor building coating inspection completed for 1EOC22 is attached. The following documents were sent to NRR on 8/15/05:

1. Laboratory analysis of the failed coatings from Unit 1
2. Coating manufacturer (Carboline) failure analysis
3. Independent technical expert failure analysis

The root cause failure analysis has been completed, reviewed, and technically approved. However, it has not yet received a formal review from the Site Corrective Action Review Board. When this is completed, we will forward the analysis under separate cover letter.

2a) Provide a copy of the original design coating specification that was used in the application of the original coating system and documentation supporting how the specification was met.

The following were forwarded to NRC on 8/15/05:

1. Original (1969) coating specification
2. Current coating specification that describes the original coating system.

We have been unable to locate specific documentation of coatings application procedures or inspection records for original application. The original reactor building coatings work at Oconee Units 1, 2 and 3 was performed approximately 35 years ago. Coating work was performed in accordance with the original (1969) coating specifications and standard industrial practices in effect during that time period. Interviews with individuals present during site construction indicate that coating applications were based on "skill of the craft" and coatings supervisors/foremen monitored the quality of the work.

Although evidently not typical for the nuclear industry during this time period, Oconee does have quality control records for the original coating material supplied by the manufacturer. Internal correspondence dated May 1971 states "Carboline indicates that of all the nuclear plants they supplied materials for, only three customers asked for quality assurance of materials." Duke/Oconee was one of the listed customers.

2b) Include the evaluation, analysis and/or acceptance criteria that demonstrate the original coating system may be designated as acceptable per your licensing basis.

The definition of an acceptable coating system is found in EPRI TR-109937, Guidelines on Nuclear Related Coatings and ASTM D5144-00, Standard Guide for use of Protective Coating in Nuclear Power Plants. The definition is as follows:

"A safety-related coating system for which a suitability for application review which meets the plant licensing requirements has been completed and there is reasonable assurance that, when properly applied and maintained, the coating will not detach under normal or accident conditions".

The original containment liner plate coatings at ONS are considered acceptable on the basis of DBA testing sponsored by the coatings supplier (Carboline) and documented in Table 3-12 of the ONS UFSAR. Quality Control (QC) records were obtained to provide further assurance of material quality. As mentioned in question 2(a), application of the coatings was performed using standard industry practices which relied upon "skill of the craft" and supervisory oversight for quality assurance. This was the commonly accepted practice at the time the work was performed, and generally produced a quality result. We have seen some failures of this system in localized areas over the approximately 35 years of service. However, with proper adherence to our coatings maintenance program, we are confident that the quantity of coatings subject to delamination under normal and accident conditions can be managed at a minimal level.

2c) In the absence of any records of the application of the original coatings, how are you assured that the coatings meet the acceptance criteria. What is the basis for determining the coating is acceptable? This is applicable to the exposed inorganic zinc and the IOZ/epoxy coating systems that exist.

Without records of the application procedures and inspections, absolute assurance of meeting acceptance criteria cannot be provided. However, there is substantial basis for determining the coating system to be acceptable.

The definition of an "Acceptable" coating stipulates that the coating "will not detach under normal or accident conditions". Design Basis Accident (DBA) testing exists (the EPRI DBA Coating Qualification Test Report Database) for various thicknesses of both the Carbo Zinc 11 primer (alone) and the original coating system (Carbo Zinc 11 primer, Phenoline 305 topcoat). The performance of the zinc primer/top coat combination, based upon available DBA test results, has been determined to be "acceptable". DBA testing is also available for untopcoated zinc and provides reasonable assurance that untopcoated zinc will not delaminate during normal and accident scenarios. It is recognized that the Unit 1 containment coating root cause evaluation indicates improper application

techniques 35+ years ago; however the existing degraded coatings are limited to specific areas that have already manifested and have been remediated or left in place where low safety significance did not justify remediation. New areas of delaminated coating that develop during run cycles are typically adjacent to those areas where the delaminated topcoat was previously removed.

As noted in our response on 4/29/05 to RAI's issued 3/30/05, ONS explained that we have evaluated the safety significance of coatings delamination as early as 1997. Our conclusion was that delaminated coatings (ie, debris in the form of paint chips) would be unlikely to transport to the Reactor Building Emergency Sump. Test data reported more recently in NUREG/CR-6808 still support that conclusion today. In view of these tests and analyses, we feel that the containment liner plate coatings are being maintained at an acceptable level of delamination from a safety perspective, and in a manner that meets our licensing basis requirements to minimize delaminated coatings as documented in our response to GL 98-04.

In locations where the zinc primer is exposed, there is a thin residual layer of loose zinc particulate on the surface. However, the primer that remains is tightly adhered to the substrate. The failure analysis report prepared by the independent consultant (Corrosion Control Consultants and Labs, Inc.) with respect to polar crane zinc states "I found that the Carbo Zinc 11 primer had almost no cohesive strength and that the primer could be easily removed to substrate as a fine powder without detection of any competent coating film." However, during the 1EOC-22 outage we removed over 4000 square feet of delaminated coating including scraping portions of the polar crane, polar crane supports, spray steel and liner plate. Personnel involved with this work activity in the polar crane area were questioned and reported no instances where our remediation efforts exposed the substrate. Based on our 1EOC-22 outage experience, it is Oconee's observation that the zinc primer is so tightly adhered that a power tool is required to remove it from the substrate. This experience, in the view of ONS and with concurrence of the coating manufacturer, supports a position that exposed zinc alone can be considered an acceptable coating system.

The safety aspects of untopcoated zinc failures are sump screen blockage and downstream effects. Sump screen blockage is not considered credible, as zinc is known to fail in powdery particulate form which would easily pass through a sump screen. ONS uses Reflective Metallic Insulation (RMI) exclusively inside the secondary shield walls of containment, where piping insulation is subject to break jet forces capable of generating debris. Realistically, the formation of a thin bed of fiber, even on our existing sump screen, is small. Thus, the potential for sump screen blockage is low. Downstream effects of such debris has not been evaluated to date. These issues will be fully addressed in our response to Generic Letter 2004-02, as described in our response dated 9/1/05.

In addition to the visual inspections and dry film thickness measurements conducted as part of the outage coating assessments, both the coating manufacturer and our technical consultant independently performed several ASTM D6677 (Adhesion by Knife) tests on the Unit 1 liner plate during 1EOC22. The testing performed indicates that the remaining coating system is tightly adhered. Approximately 4 or 5 tests total were performed on various locations on the liner plate around the 4th floor. Quoting from the coating failure analysis by Corrosion Control Consultants and Labs, Inc.:

" I also performed adhesion testing of visually sound coating adjacent to several failure areas on the Containment liner plate in accordance with ASTM D6677-01, "Standard Test Method for Evaluating Adhesion by Knife." All areas tested ranged from 8 to 10, which indicate the presence of sound coating."

In summary, assurance of acceptability is based upon the following elements:

1. Procurement of quality coating materials with appropriate DBA qualifications.
2. DBA testing shows this coating system, properly applied, will handle post-LOCA containment environment.
3. Minimal delamination of the original coating system has been observed by visual inspection after 30+ years of service.
4. Safety aspects of coating failures have been addressed consistent with industry knowledge base and the plant licensing basis.
5. ONS testing (knife tests, etc.) demonstrates sound coatings with good adhesion for original coating systems.
6. Power tool removal Operating Experience demonstrates sound coating (good adhesion) for areas of exposed inorganic zinc (IOZ).
7. Original coatings were applied utilizing standard industry practices which relied upon "skill of the craft" and supervisory oversight for quality assurance.
8. Good adhesion supports an assumption of quality application.
9. Proper application plus DBA testing equals acceptable coating.

3a) Provide a detailed description of any testing of the coatings that was performed in addition to the visual inspection. Include the results of the tests, and the extent of testing performed.

In accordance with ASTM D5163-96 and EPRI TR-109937 (Guidelines on Nuclear Safety Related Coatings) and endorsed by ASTM Committee D-33 (Protective Coating and Lining Work for Power Generation Facilities), visual inspection is the primary coating condition assessment tool employed at Oconee. EPRI TR-109937 does provide other options upon identification of non-conforming conditions including:

1. Additional Testing
2. Remove/Replace Coating
3. Repair Coating
4. Mitigate Accident Consequences
5. Leave In Place Based On Evaluation Of Effects on Safety
6. Upgrade Indeterminate Coating

In addition to the visual inspections and dry film thickness measurements conducted as part of the outage coating assessments, both the coating manufacturer and our technical consultant independently performed several ASTM D6677 (Adhesion by Knife) tests on the Unit 1 liner plate during 1EOC22 refueling outage (Spring 2005). The testing performed indicates that the remaining coating system is tightly adhered. A minimum of four tests were performed on various locations on the liner plate around the 4th floor. However, the independent consultant's "Adhesion by Knife" testing of the sound coating adjacent to failure areas on the polar crane indicated poor adhesion results. Extensive remediation was performed on the polar crane prior to startup, removing essentially all topcoat from this area.

During 2EOC21 refueling outage (Fall 2005), ASTM D6677 (Adhesion by Knife) testing will be performed on the top coat in random accessible locations adjacent to permanently removed degraded coatings. This will provide reasonable assurance that degraded coating was removed and what remains is sound, tightly adhered coating. It is important to note that the ASTM D6677 test is an enhancement to ASTM D3359 which was determined acceptable to the NRC in RG 1.54 for measuring coating adhesion. In the event of a testing failure, the scope of remediation will be expanded or one of the other options listed above (per EPRI TR-109937 guidance) will be pursued.

Additionally, during 2EOC21, Oconee plans to perform ASTM D4752 (MEK Rub test) in selected areas of exposed zinc primer. This is based on our internal technical review and recommendations from the coating manufacturer and an independent technical consultant. This test employs manual abrasion of the coating to determine adequate adhesion. In the event of a testing failure, the scope of remediation will be expanded or one of the other options listed above (per EPRI TR-109937 guidance) will be pursued.

To provide further assurance of sound adhesion, random ASTM D6677 (Adhesion by Knife) testing and Dry Film Thickness (DFT) readings in multiple locations of visually sound surfaces throughout the Reactor Building will be taken during the upcoming 2EOC-21, 3EOC 22 and 1EOC 23 outages (next outage per unit). The tested areas will include liner plate, polar crane, and polar crane ring girder.

3b) Provide a justification for why the inspections and testing provide assurance that the coating systems will remain intact under DBA conditions.

EPRI maintains a DBA Coating Qualification Test Report Database for the nuclear industry. Design Basis Accident testing exists for various thicknesses of the original coating system (Carbo Zinc 11 primer, Phenoline 305 topcoat). The performance of the zinc primer/top coat combination was found to be acceptable. This testing clearly demonstrates that this coating system, properly applied, will remain intact under DBA conditions.

As previously stated, visual inspection is the primary coating assessment tool. Visual inspection has been the industry standard for many years, and is endorsed by ASTM and EPRI as a recommended practice. Our own experience has shown that visual inspection will reveal areas where application problems are manifesting. Film thickness measurements and knife tests described in question 3(a) above also provide indications of sound adhesion which support a conclusion of proper application. Thus, with evidence of proper application and a documented DBA test regimen as described above, there is reasonable assurance that the coatings will not detach during a DBA.

3c) How can you correlate the as tested condition of the coating to its original acceptance criteria?

There is currently no published standard which provides a direct quantitative correlation between any adhesion testing and DBA tests. However, the objective of such testing is not to correlate to DBA testing, but to establish whether or not the coating is tightly adhering to the substrate. If tight adherence can be confirmed, a basis exists for concluding that the coating system was properly applied. A properly applied coating system which has been supported by DBA testing is considered an acceptable system for this application.

4.) Oconee considers exposed inorganic zinc resulting from the remediation process, or from degradation of the epoxy topcoat, to be an acceptable coating. This zinc was a part of the original coating system that failed, and could be the cause for the epoxy delaminating. If the inorganic zinc was a contributor to the failure it may not remain adhered in the case of a LOCA. What is your basis for considering the zinc primer that remains after delamination or remediation of the epoxy topcoat an acceptable coating.

Completed failure analysis by both the manufacturer and independent technical consultant indicates that the zinc 1) was a part of the original coating system that failed and 2) is one cause for the epoxy delaminating. All of the failures were cohesive failures (within the zinc primer film) vs. adhesive failures (failures at the coating/substrate interface). During the curing process, the binding agent (ethyl silicate) is attached to the substrate. Excessive primer thickness results in a thin

film of loosely adhered zinc particles on the outside surface only. In locations where the topcoat is delaminated or has been removed, the residual primer (zinc + binding agent) remains tightly adhered to the substrate. Our experience has shown that in the process of abatement, the zinc primer remains so tightly adhered that a power tool is required to remove it from the substrate.

The EPRI DBA Coating Qualification Test Report Database includes documentation of six (6) different testing projects with untopcoated Carbo Zinc 11 primer only. The test report indicates that the test panels passed each of the DBA tests performed. However, test panels with excessive Carbo Zinc 11 primer resulted in powdering after a six (6) hour LOCA. The mode of failure confirmed that zinc loss occurred in very fine particles.

ONS recognizes that failures noted above do call into question the ability of the remaining untopcoated zinc to withstand a LOCA, since the tests discussed above were performed on "sound" zinc coating which had not been part of such a failed coating system. We simply note that our own operating experience gained from inspections and remediation efforts suggests that the untopcoated zinc will perform acceptably. We would also note that the particulate contribution from untopcoated zinc represents a small fraction of the total particulate loading predicted for the emergency sump. Thus, the safety significance is relatively low.

As we go forward, ONS will address untopcoated zinc and its effects on sump blockage and function of downstream components in the ECCS and CSS post-LOCA sump recirculation flow path. Our plans for completing this work are described in our response to GL 2004-02.